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# NATIONAL BUREAU OF STANDARDS REPORT

2846

PERFORMANCE TESTS OF CLEANABLE  
IMPINGEMENT-TYPE AIR FILTERS  
(Farr Type 44G)

by

Henry E. Robinson  
Thomas W. Watson



U. S. DEPARTMENT OF COMMERCE  
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● Office of Basic Instrumentation

● Office of Weights and Measures.

# NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT

NBS REPORT

1003-20-4715

October 9, 1953

2846

## PERFORMANCE TESTS OF CLEANABLE IMPINGEMENT-TYPE AIR FILTERS (Type 44G)

manufactured by  
The Farr Company  
Los Angeles, California

by

Henry E. Robinson  
Thomas W. Watson  
Heating and Air Conditioning Section  
Building Technology Division

to

Bureau of Ships, Code 327  
Department of the Navy

Reference: NPO - 15479 Index No. NSM 130-001



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# PERFORMANCE TESTS OF A FARR TYPE 44G AIR FILTER

## I. INTRODUCTION

At the request of the Bureau of Ships, Code 327, Navy Department (NPO-15479, Index No. NSM 130-001) qualification tests were made to determine the performance of cleanable viscid-impingement type air filters in accordance with Section 4.5 of Military Specification MIL-F-16552 (Ships) dated 1 October 1951 as modified by Amendment 1 dated 15 April 1952.

The tests were performed on a specimen filter submitted by the manufacturer at the request of the Bureau of Ships, and included determinations of the dust-arresting efficiency, pressure drop, specific dirt load and cleanability of the specimens at three face air velocities, namely 300, 600, and 900 feet per minute.

## II. DESCRIPTION OF THE FILTER SPECIMEN

The filter was manufactured by the Farr Company of Los Angeles, California, and was of the cleanable viscid type, 20 x 20 x 2 inches in nominal size. It was identified by nameplate as a Farr Type 44G.

The filtering media was composed of layers of 14-inch mesh screen wire in strips arranged and piled in alternate layers of flat and v-crimped screen. The media was held together at the edges by a steel retaining frame. There were approximately 4 layers of flat screen and 4 layers of v-crimp screen per inch of pile.

The filter had actual outside dimensions of 19 1/2 x 19 5/8 x 2 inches, and had a free opening 18 3/8 x 18 1/4 inches in size (2.33 ft<sup>2</sup> net face area). It weighed 10.2 lb when clean, without oil.

The manufacturer submitted an adhesive designated as "Green Bloom 100" for oiling the filter. This was done in preparation for test by immersing the filter in the liquid and letting the excess oil drain off at a temperature of 75° F or above, with the filter standing on edge for a minimum of 24 hours prior to the test.

### III. TEST METHOD AND PROCEDURE

The dust-arresting efficiency of the filter was determined by the NBS "Dust Spot Method" using as a test dust Cottrell precipitate at a concentration of one gram per thousand cubic feet of air. The test method is described in the paper "A Test Method for Air Filters" by R. S. Dill (ASHVE Transactions, Vol. 44, p. 379, 1938).

Dirt-holding capacity was determined by supplying to the filter air in which were dispersed cotton lint and Cottrell precipitate in the approximate proportions of 4% and 96% by weight, respectively. The average rate of feed of the contaminants was not more than 25 grams per hour per square foot of net filter face area at each face velocity. The lint used for this purpose was No. 7 cotton linters ground in a Wiley mill with 4 mm screen.

The efficiency and dirt-loading tests were made at three different air velocities, namely, 300, 600, and 900 fpm.

In the tests at each velocity, the following uniform procedure was employed. The clean filter, after oiling and draining as described above, was installed in the test duct and its initial pressure drop was measured at 300, 600, and 900 fpm air velocity. The initial efficiency of the filter at the test velocity was then determined, following which the process of loading the filter with a mixture of 4% lint and 96% Cottrell precipitate by weight was started. At intervals, the increasing pressure drop of the filter was recorded. At suitable periods as loading progressed, the efficiency of the filter was determined using 100% Cottrell precipitate. In addition, the efficiency of the filter was determined at the end of a day of loading, and at the start of the next day, to ascertain whether the rate of dirt loading was overtaking the wetting rate of the filter adhesive. The dirt loading was continued, in general, until the rate of pressure drop rise increased to approximately 0.004 inch W.G. per gram of dirt mixture fed per square foot of filter face area.

The filter was then removed from the test duct and cleaned by means of a stream of cold water from a high-pressure hose nozzle, directed at and into the filter media. After drying, the filter was re-oiled for subsequent tests or for measurement of its initial pressure drop after the final cleaning.

#### IV. TEST RESULTS

The pressure drop of the clean oiled filter, in inch W.G., at 300, 600, and 900 face air velocity, was measured at the start of each of the tests and after the 900 fpm test, as shown in Table 1.

Table 1

Face Velocity, fpm	300	600	900
At start of 300 fpm test	0.037	0.131	0.275
At start of 600 fpm test	.041	.143	.299
At start of 900 fpm test	.043	.154	.318
After 900 fpm test	.043	.155	.325
Increase in P.D. after 3 cleanings, percent	16	18	18

A summary of the test data obtained in dirt-loading tests conducted at 300, 600, and 900 fpm face velocity is given in Table 2

Table 2

Face Air Velocity fpm	Dirt Load* grams/sq ft	Pressure Drop inch WG	Efficiency percent
300	0	0.037	---
	3	.037	54
	5	.037	53
	72	.057	50(P)
	75	.053	52(A)
	155	.076	---
	196	.097	53(P)
	199	.091	53(A)
	251	.161	58
	274	.215	64
	289	.285	68
	302	.342	69(P)
	305	.358	70(A)
	323	.535	78

\*Average mixture: 3.9% lint, 96.1% Cottrell precipitate by weight.

Average rate of dirt loading: 16.6 grams per square foot per hour.

Table 2 - continued

<u>Face Air Velocity</u> fpm	<u>Dirt Load*</u> grams/sq ft	<u>Pressure Drop</u> inch WG	<u>Efficiency</u> percent
600	0	0.143	---
	6	.145	60
	12	.148	62
	62	.205	62
	120	.250	63(P)
	126	.228	63(A)
	161	.258	62
	232	.360	64
	252	.393	64(P)
	258	.412	64(A)
	294	.525	71
	338	.761	73

\*Average mixture: 4.0% lint, 96% Cottrell precipitate by weight.

Average rate of dirt loading: 21.6 grams per square foot per hour.

900	0	0.318	---
	9	.320	65
	17	.328	63
	106	.501	69
	160	.571	70(P)
	169	.563	68(A)
	240	.703	76
	286	.810	76(P)
	295	.840	75(A)
	330	1.016	77

\*Average mixture: 4.0% lint, 96% Cottrell precipitate by weight.

Average rate of dirt loading: 22.2 grams per square foot per hour.

NOTE: Efficiencies marked (P) or (A) were determinations made at the end of a day of loading, and at the start of the next day of loading, respectively.

## V. SUMMARY OF RESULTS

### A. Performance

The test data are plotted in Figure 1, which shows the variation of the pressure drop and of the efficiency of the filter as it was subjected to increasing specific dirt loading at face velocities of 300, 600, and 900 feet per minute.

Table 3 presents values of the pressure drop (P.D.) in inches of water, and of the approximate efficiency (Eff.) in percent, as taken from the curves of Figure 1, at various specific dirt loadings.

Table 3

Spec. Dirt Ldg. grams/ sq ft	0 (Initial)		100		200		300	
Face Vel. fpm	P.D.	Eff.	P.D.	Eff.	P.D.	Eff.	P.D.	Eff.
300	0.04	54	0.06	52	0.09	53	0.33	69
600	.14	60	.24	63	.31	63	.55	71
900	.32	65	.49	69	.63	69	.85	75

### B. Cleanability

The pressure drops of the clean oiled filter at 300, 600, and 900 fpm face velocity recorded in Table 1 under Test Results indicate that, after the filter had been subjected to three loadings with the dust-lint mixture and three cleanings and re-oilings, its average percentage increase in pressure drop was about 17.3 percent, or about 5.8 percent per loading and cleaning operation. However, although these readings seem to indicate a gradual build-up of filter resistance, thorough visual examination of the filter media after cleaning at the end of the tests revealed no perceptible dirt deposits not removed by the washing operation. The adhesive furnished by the manufacturer and used for oiling the media was unusually viscous - it was estimated to have a viscosity not less than that designated as

SAE 50. It is possible that the changes in filter pressure drop were due to variations in the amount of the oil retained after the oiling and draining operation, which, however, was carried out in a uniform manner. In view of the fact that the filter appeared thoroughly clean at the end of the tests, it is believed it can be considered as satisfactorily cleanable.

#### C. General

The fact that efficiencies determined at the end of a day of loading of the filter (those marked (P) in Table 2) were approximately the same as those made at the start of the next day of loading (those marked (A)) indicates that the dirt-loading rates to which the filter was subjected did not overtax the wetting-rate of the filter adhesive and cause the filter surfaces to become "dry".

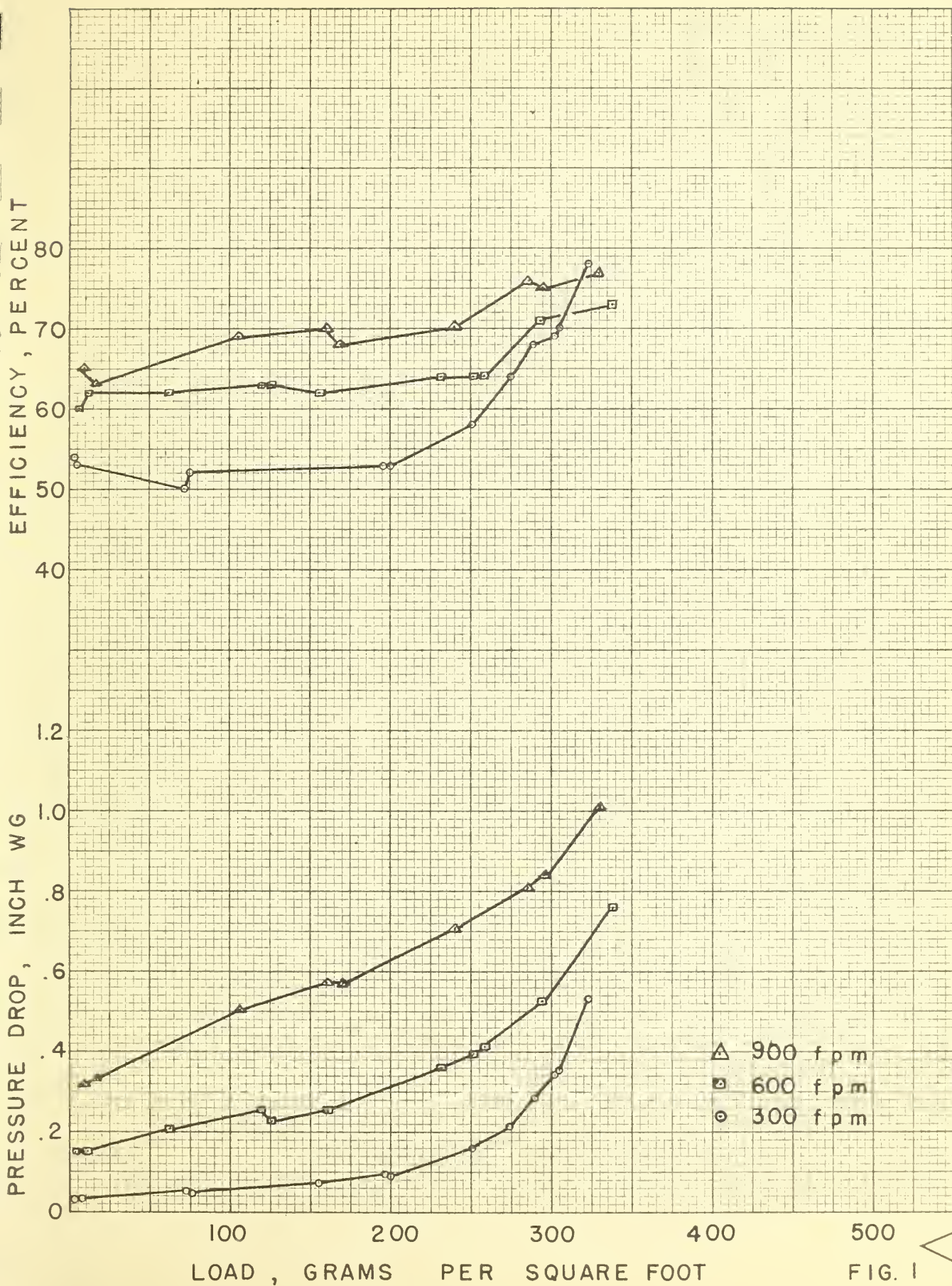


FIG. I



## **THE NATIONAL BUREAU OF STANDARDS**

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The functions of the National Bureau of Standards are set forth in the Act of Congress, March 3, 1901, as amended by Congress in Public Law 619, 1950. These include the development and maintenance of the national standards of measurement and the provision of means and methods for making measurements consistent with these standards; the determination of physical constants and properties of materials; the development of methods and instruments for testing materials, devices, and structures; advisory services to Government Agencies on scientific and technical problems; invention and development of devices to serve special needs of the Government; and the development of standard practices, codes, and specifications. The work includes basic and applied research, development, engineering, instrumentation, testing, evaluation, calibration services, and various consultation and information services. A major portion of the Bureau's work is performed for other Government Agencies, particularly the Department of Defense and the Atomic Energy Commission. The scope of activities is suggested by the listing of divisions and sections on the inside of the front cover.

### **Reports and Publications**

The results of the Bureau's work take the form of either actual equipment and devices or published papers and reports. Reports are issued to the sponsoring agency of a particular project or program. Published papers appear either in the Bureau's own series of publications or in the journals of professional and scientific societies. The Bureau itself publishes three monthly periodicals, available from the Government Printing Office: The Journal of Research, which presents complete papers reporting technical investigations; the Technical News Bulletin, which presents summary and preliminary reports on work in progress; and Basic Radio Propagation Predictions, which provides data for determining the best frequencies to use for radio communications throughout the world. There are also five series of nonperiodical publications: The Applied Mathematics Series, Circulars, Handbooks, Building Materials and Structures Reports, and Miscellaneous Publications.

Information on the Bureau's publications can be found in NBS Circular 460, Publications of the National Bureau of Standards (\$1.00). Information on calibration services and fees can be found in NBS Circular 483, Testing by the National Bureau of Standards (25 cents). Both are available from the Government Printing Office. Inquiries regarding the Bureau's reports and publications should be addressed to the Office of Scientific Publications, National Bureau of Standards, Washington 25, D. C.

